ASTEX – An In-Situ Exploration Mission to two Near-Earth-Asteroids. A. Nathues[1], H. Boehnhardt[1], A.W. Harris[2], W. Goetz[1], C. Gritzner[3], C. Jentsch[4], N. Schmitz[2], S. Schaeff[6], F. Weischede[5], and A. Wiegand[6]
[1]Max-Planck-Institute for Solar System Research, Max-Planck-Straße 2, 37191 Katlenburg-Lindau, Germany, e-mail: nathues@mps.mpg.de; [2]DLR Institute of Planetary Research, 12489 Berlin; [3]DLR, 53227 Bonn; [4]Astrium GmbH, 88039 Friedrichshafen; [5]DLR, Oberpfaffenhofen, 82234 Weßling; [6]Astos Solutions, 78089 Unterkirnach

Introduction: ASTEX is a feasibility study of an in-situ exploration mission to two near-Earth asteroids (NEAs) funded by the German Space Agency DLR. The mission objectives call for targets with different mineralogical compositions: one asteroid should be of "primitive" nature, the other one should be a fragment of a differentiated asteroid. The goals of the mission are to explore the physical, geological and mineralogical nature of the asteroids and to provide information and constraints on the formation and evolution history of our planetary system. In addition, the detailed knowledge of the properties of NEAs will allow for the selection of potential mitigation systems when required.The mission scenario consists of an orbiting and landing phase at each target.

Aims of the study: The primary aim of the study is to define the high-level goals of the ASTEX mission as well as to identify and to analyze mission scenarios which support these goals. The study includes:

1) Identification of potential target pairs, optimized trajectories and orbits around NEAs.
2) Identification of the optimum propulsion system.
3) Selection of the scientific strawman payload of orbiter and lander systems.
4) Analysis of the requirements and options for the spacecraft bus and the lander system.
5) Identification of the requirements for the operational ground segment.

Scientific aims: Primitive and differentiated asteroids represent two main formation stages of the building blocks (planetesimals) of the terrestrial planets, which are important for our understanding of the origin and evolution of the solar system. Two scientific aspects play an important role, i.e. the search for, and study of the origin and evolution of, primordial material that may have played a role in the formation of life in the solar system, and the understanding of the processes that have led to differentiated planetary embryos in the asteroid belt. Beside these, the following immediate mission aims have been defined:

1) Determination of the inner structure of the bodies.
2) Search for material relevant to the formation of life.
3) Determination of the basic physical parameters of the targets (e.g., size, shape, mass, etc.).
4) Determination of thermal conductivity, roughness, material strength and other surface physical properties.
5) Visible and near-IR mapping of the surfaces to determine the morphology, the chemistry, the mineralogy and the geology of the targets.
6) Investigation of the correlation between meteorite classes and asteroid types.
7) Exact determination of an asteroid orbit around the Sun using radio tracking.
8) Provision of essential information for mitigation strategies against hazardous NEAs.

Technological aims: To meet the scientific goals several innovative technologies need to be developed or optimized in the future:

1) Spacecraft bus designed for approaching multiple targets, and a low-thrust propulsion system (e.g. solar-electric propulsion) which allows long-duration thrusting.
2) Low mass lander system equipped with robotic tools for payload positioning and surface digging.
3) Miniaturized lander payload (panoramic camera, microscope, electron microscope, temperature sensors, Moessbauer spectrometer).
4) Radar for tomographic investigation of the inner structure.
5) Autonomous on-board control systems

Mission scenarios: From the huge number of possible NEA combinations 1210 have been pre-selected and the respective transfers computed within the period 2015 to 2040. In a final step further down-selection to 4 combinations and 3 backup combinations took place. Selection criteria like asteroid taxonomy, mission duration, stop-over times at the asteroids etc. were considered.

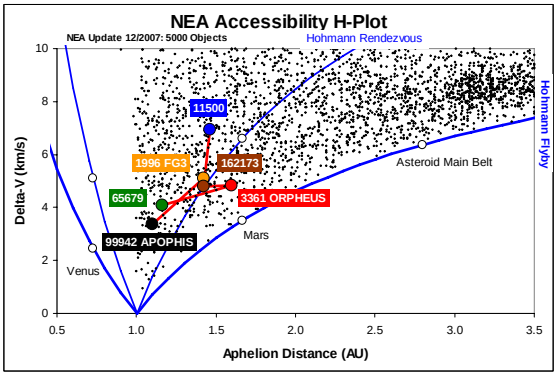

Fig. 1 *ΔV versus aphelion distance for the studied NEAs. The selected ASTEX NEA combinations are marked.*